

mechanics have valuable experience and training. Persons who enter from related occupations may start as trainees or helpers, however, they may require less on-the-job training.

Employers look for skilled individuals with the aptitude needed to handle tools and equipment. Occasionally, strength is required to lift, move, or hold heavy parts in place. Difficult repair jobs require problem-solving skills to diagnose the source of the machine's malfunction and choose the correct course of action to fix the problem. The importance of computer skills will increase as many more dealers gain access to computerized diagnostic equipment on a laptop computer. This technology will allow mechanics to simply plug into the farm equipment and do a complete diagnostic check by pushing a button. Experienced mechanics should be able to work independently with minimal supervision.

Farm equipment mechanics may keep abreast of changes in farm equipment technology by going to trade shows, by reading the latest farm equipment literature, and by carefully studying service manuals and analyzing complex diagrams. Many farm equipment mechanics and trainees receive refresher training in short-term programs conducted by farm equipment manufacturers. This is the dealers' way of keeping their employees trained in the latest technology and standards within the industry. A company service representative explains the design, function, and techniques required to repair and maintain new models of farm equipment. In addition, some dealers may send employees to local vocational schools that hold special week-long classes in subjects such as air-conditioning repair or hydraulics. Training courses delivered via satellite and video tapes have become increasingly popular ways to standardize training techniques and to cut expenses needed to reach individual dealers and repair shops.

Mechanics' personal tools are very important to their livelihood. Farm equipment mechanics usually buy their own handtools, although employers furnish power tools and computerized test equipment. Trainee mechanics are expected to accumulate their own tools as they gain experience. Experienced mechanics have thousands of dollars invested in their tools.

Farm equipment mechanics may advance to shop supervisor, service manager, or manager of a farm equipment dealership. Some mechanics open their own repair shops or invest in franchised dealers. A few farm equipment mechanics with strong customer service backgrounds advance to service representatives for farm equipment manufacturers.

Job Outlook

Employment of farm equipment mechanics is expected to decline through the year 2008. Most job openings will arise from the need to replace experienced mechanics who retire. Nevertheless, job opportunities should be good for persons who have completed formal training in farm equipment repair, diesel mechanics, or a similar program. Employers of farm equipment mechanics report difficulty finding qualified candidates to fill available positions because people trained to repair farm equipment have the fundamental skills and knowledge to work as mechanics in industries outside agriculture. Many young people with mechanic training prefer to take jobs as automotive mechanics, diesel mechanics, heavy equipment mechanics, or industry machine repairers, all occupations that offer relatively higher earnings and a wider variety of locations in which to work.

Some consolidation of farmland into fewer and larger farms is expected to continue through 2008. Although farmers may need a smaller stock of equipment in the years ahead, they will keep investing in newer, more efficient and more specialized equipment to till greater acreage more productively and profitably. For example, new planting equipment uses electronics to spread seeds more uniformly. Many modern tractors have large, electronically controlled engines, and air-conditioned cabs, and feature advanced transmissions with many speeds. The new machinery is expensive, usually being designed and manufactured to withstand many years of rugged use. However, it requires periodic service and repairs. The increased complexity of such equipment means that trained mechanics will make repairs rather than the farmers.

Sales of smaller lawn and garden equipment constitute a growing share of the business of most farm equipment dealers. Most large manufacturers of farm equipment now offer a line of smaller tractors to sell through their established dealerships. This equipment, however, is designed for easy home service and only requires a mechanic when major repairs are needed.

The agricultural equipment industry experiences periodic declines in sales. Layoffs of mechanics, however, are uncommon because farmers often elect to repair old equipment rather than purchase new equipment.

Earnings

Median hourly earnings of farm equipment mechanics in 1998 were \$10.94. The middle 50 percent earned between \$8.86 and \$13.20. The lowest 10 percent earned less than \$6.96 and the top 10 percent earned more than \$16.01. Most farm equipment mechanics also have the opportunity to work overtime during the planting and harvesting seasons, which generally pays time and one-half.

Very few farm equipment mechanics belong to labor unions, but those who do are members of the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; and the International Brotherhood of Teamsters.

Related Occupations

Other workers who repair large mobile machinery include aircraft mechanics, automotive mechanics, diesel engine specialists, and mobile heavy equipment mechanics.

Sources of Additional Information

Details about work opportunities may be obtained from local farm equipment dealers and local offices of the State employment service. For general information about the occupation, write to:

✉ North American Equipment Dealers Association, 10877 Watson Rd., St. Louis, MO 63127.

Heating, Air-Conditioning, and Refrigeration Mechanics and Installers

(O*NET 85902A and 85902B)

Significant Points

- Opportunities should be very good for mechanics and installers with technical school or formal apprenticeship training.
- Mechanics and installers need a basic understanding of microelectronics because they increasingly install and service equipment with electronic controls.

Nature of the Work

What would those living in Chicago do without heating, those in Miami do without air-conditioning, or blood banks in all parts of the country do without refrigeration? Heating and air-conditioning systems control the temperature, humidity, and the total air quality in residential, commercial, industrial, and other buildings. Refrigeration systems make it possible to store and transport food, medicine, and other perishable items. Heating, air-conditioning, and refrigeration mechanics and installers, also called technicians, install, maintain, and repair such systems.

Heating, air-conditioning, and refrigeration systems consist of many mechanical, electrical, and electronic components such as motors, compressors, pumps, fans, ducts, pipes, thermostats, and switches. In central heating systems, for example, a furnace heats air

that is distributed throughout the building via a system of metal or fiberglass ducts. Technicians must be able to maintain, diagnose, and correct problems throughout the entire system. To do this, they adjust system controls to recommended settings and test the performance of the entire system using special tools and test equipment.

Although they are trained to do both, technicians often specialize in either installation or maintenance and repair. Some specialize in one type of equipment—for example, oil burners, solar panels, or commercial refrigerators. Technicians may work for large or small contracting companies or directly for a manufacturer or wholesaler. Those working for smaller operations tend to do both installation and servicing, and work with heating, cooling, and refrigeration equipment.

Furnace installers, also called *heating equipment technicians*, follow blueprints or other specifications to install oil, gas, electric, solid-fuel, and multiple-fuel heating systems. After putting the equipment in place, they install fuel and water supply lines, air ducts and vents, pumps, and other components. They may connect electrical wiring and controls and check the unit for proper operation. To ensure the proper functioning of the system, furnace installers often use combustion test equipment such as carbon dioxide and oxygen testers.

After a furnace has been installed, technicians often perform routine maintenance and repair work to keep the system operating efficiently. During the fall and winter, for example, when the system is used most, they service and adjust burners and blowers. If the system is not operating properly, they check the thermostat, burner nozzles, controls, or other parts to diagnose and then correct the problem. During the summer, when the heating system is not being used, technicians do maintenance work, such as replacing filters and vacuum-cleaning vents, ducts, and other parts of the system that may accumulate dust and impurities during the operating season.

Air-conditioning and refrigeration technicians install and service central air-conditioning systems and a variety of refrigeration equipment. Technicians follow blueprints, design specifications, and manufacturers' instructions to install motors, compressors, condensing units, evaporators, piping, and other components. They connect this equipment to the duct work, refrigerant lines, and electrical power source. After making the connections, they charge the system with refrigerant, check it for proper operation, and program control systems.

When air-conditioning and refrigeration equipment breaks down, technicians diagnose the problem and make repairs. To do this, they test parts such as compressors, relays, and thermostats. During the winter, air-conditioning technicians inspect the systems and do required maintenance, such as overhauling compressors.

When heating, air-conditioning, and refrigeration technicians service equipment, they must use care to conserve, recover, and recycle chlorofluorocarbon (CFC) and hydrochlorofluorocarbon

(HCFC) refrigerants used in air-conditioning and refrigeration systems. The release of CFCs and HCFCs contributes to the depletion of the stratospheric ozone layer, which protects plant and animal life from ultraviolet radiation. Technicians conserve the refrigerant by making sure that there are no leaks in the system; they recover it by venting the refrigerant into proper cylinders; and they recycle it for reuse with special filter-dryers.

Heating, air-conditioning, and refrigeration technicians are adept at using a variety of tools, including hammers, wrenches, metal snips, electric drills, pipe cutters and benders, measurement gauges, and acetylene torches, to work with refrigerant lines and air ducts. They use voltmeters, thermometers, pressure gauges, manometers, and other testing devices to check air flow, refrigerant pressure, electrical circuits, burners, and other components.

New technology, in the form of cellular "Web" phones that allow technicians to tap into the Internet, may soon affect the way technicians diagnose problems. Computer hardware and software have been developed that allows heating, venting, and refrigeration units to automatically contact the maintenance establishment when problems arise. The maintenance establishment can then notify the technician in the field via cellular phone. The technician then accesses the Internet to "talk" with the unit needing maintenance. While this technology is cutting-edge and not yet widespread, its potential for cost-savings may spur its acceptance.

Other craft workers sometimes install or repair cooling and heating systems. For example, on a large air-conditioning installation job, especially where workers are covered by union contracts, duct work might be done by sheet-metal workers and duct installers; electrical work by electricians; and installation of piping, condensers, and other components by plumbers, pipefitters, and steamfitters. Home appliance repairers usually service room air-conditioners and household refrigerators. (Additional information about each of these occupations appears elsewhere in the *Handbook*.)

Working Conditions

Heating, air-conditioning, and refrigeration mechanics and installers work in homes, stores of all kinds, hospitals, office buildings, and factories—anywhere there is climate-control equipment. They may be assigned to specific job sites at the beginning of each day, or if they are making service calls, they may be dispatched to jobs by radio, telephone, or pagers. Increasingly, employers are using cell phones to coordinate technicians' schedules.

Technicians may work outside in cold or hot weather or in buildings that are uncomfortable because the air-conditioning or heating equipment is broken. In addition, technicians often work in awkward or cramped positions and sometimes are required to work in high places. Hazards include electrical shock, burns, muscle strains, and other injuries from handling heavy equipment. Appropriate safety equipment is necessary when handling refrigerants because contact can cause skin damage, frostbite, or blindness. Inhalation of refrigerants when working in confined spaces is also a possible hazard, and may cause asphyxiation.

Technicians usually work a 40-hour week, but during peak seasons they often work overtime or irregular hours. Maintenance workers, including those who provide maintenance services under contract, often work evening or weekend shifts, and are on call. Most employers try to provide a full workweek the year round by scheduling both installation and maintenance work, and many manufacturers and contractors now provide or even require service contracts. In most shops that service both heating and air-conditioning equipment, employment is very stable throughout the year.

Employment

Heating, air-conditioning, and refrigeration mechanics and installers held about 286,000 jobs in 1998; more than half of these worked for cooling and heating contractors. The remainder were employed in a variety of industries throughout the country, reflecting a widespread



Heating, air-conditioning, and refrigeration mechanics rely on schematics to keep the equipment operating.

dependence on climate-control systems. Some worked for fuel oil dealers, refrigeration and air-conditioning service and repair shops, schools, and department stores that sell heating and air-conditioning systems. Local governments, the Federal Government, hospitals, office buildings, and other organizations that operate large air-conditioning, refrigeration, or heating systems employed others. Approximately 1 of every 7 technicians was self-employed.

Training, Other Qualifications, and Advancement

Because of the increasing sophistication of heating, air-conditioning, and refrigeration systems, employers prefer to hire those with technical school or apprenticeship training. A sizable number of technicians, however, still learn the trade informally on the job.

Many secondary and postsecondary technical and trade schools, junior and community colleges, and the Armed Forces offer 6-month to 2-year programs in heating, air-conditioning, and refrigeration. Students study theory, design, and equipment construction, as well as electronics. They also learn the basics of installation, maintenance, and repair.

Apprenticeship programs are frequently run by joint committees representing local chapters of the Air-Conditioning Contractors of America, the Mechanical Contractors Association of America, the National Association of Plumbing-Heating-Cooling Contractors, and locals of the Sheet Metal Workers' International Association or the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada. Other apprenticeship programs are sponsored by local chapters of the Associated Builders and Contractors and the National Association of Home Builders. Formal apprenticeship programs normally last 3 or 4 years and combine on-the-job training with classroom instruction. Classes include subjects such as the use and care of tools, safety practices, blueprint reading, and air-conditioning theory. Applicants for these programs must have a high school diploma or equivalent.

Those who acquire their skills on the job usually begin by assisting experienced technicians. They may begin performing simple tasks such as carrying materials, insulating refrigerant lines, or cleaning furnaces. In time, they move on to more difficult tasks, such as cutting and soldering pipes and sheet metal and checking electrical and electronic circuits.

Courses in shop math, mechanical drawing, applied physics and chemistry, electronics, blueprint reading, and computer applications provide a good background for those interested in entering this occupation. Some knowledge of plumbing or electrical work is also helpful. A basic understanding of microelectronics is becoming more important because of the increasing use of this technology in solid-state equipment controls. Because technicians frequently deal directly with the public, they should be courteous and tactful, especially when dealing with an aggravated customer. They also should be in good physical condition because they sometimes have to lift and move heavy equipment.

All technicians who purchase or work with refrigerants must be certified in their proper handling. To become certified to purchase and handle refrigerants, technicians must pass a written examination specific to the type of work in which they specialize. The three possible areas of certification are: Type I—servicing small appliances, Type II—high pressure refrigerants, and Type III—low pressure refrigerants. Exams are administered by organizations approved by the Environmental Protection Agency, such as trade schools, unions, contractor associations, or building groups.

The Refrigeration Service Engineers Society offers basic self-study courses for individuals with limited experience. In addition to understanding how systems work, technicians must be knowledgeable about refrigerant products, and legislation and regulation that govern their use. The industry recently announced the adoption of one standard for certification of experienced technicians: the Air Conditioning Excellence program, which is offered through North American Technician Excellence, Inc. (NATE).

Advancement usually takes the form of higher wages. Some technicians, however, may advance to positions as supervisor or service manager. Others may move into areas such as sales and marketing. Those with sufficient money and managerial skill can open their own contracting business.

Job Outlook

Job prospects for highly skilled heating, air-conditioning, and refrigeration mechanics and installers are expected to be very good, particularly for those with technical school or formal apprenticeship training to install, remodel, and service new and existing systems. In addition to job openings created by employment growth, thousands of openings will result from the need to replace workers who transfer to other occupations or leave the labor force.

Employment of heating, air-conditioning, and refrigeration mechanics and installers is expected to increase about as fast as the average for all occupations through the year 2008. As the population and economy grow, so does the demand for new residential, commercial, and industrial climate-control systems. Technicians who specialize in installation work may experience periods of unemployment when the level of new construction activity declines, but maintenance and repair work usually remains relatively stable. People and businesses depend on their climate control systems and must keep them in good working order, regardless of economic conditions.

Concern for the environment and energy conservation should continue to prompt the development of new energy-saving heating and air-conditioning systems. An emphasis on better energy management should lead to the replacement of older systems and the installation of newer, more efficient systems in existing homes and buildings. Also, demand for maintenance and service work should increase as businesses and home owners strive to keep systems operating at peak efficiency. Regulations prohibiting the discharge of CFC and HCFC refrigerants and banning CFC production by the year 2000 also should continue to result in demand for technicians to replace many existing systems, or modify them to use new environmentally safe refrigerants. In addition, the continuing focus on improving indoor air quality should contribute to the growth of jobs for heating, air-conditioning, and refrigeration technicians. Also, certain businesses contribute to a growing need for refrigeration. For example, nearly 50 percent of products sold in convenience stores require some sort of refrigeration. Supermarkets and convenience stores have a very large inventory of refrigerated equipment. This huge inventory will also create increasing demand for service technicians in installation, maintenance, and repair.

Earnings

Median hourly earnings of heating, air-conditioning, and refrigeration mechanics and installers were \$14.02 in 1998. The middle 50 percent earned between \$11.04 and \$17.90 an hour. The lowest 10 percent earned less than \$8.78 and the top 10 percent earned more than \$22.29. Median hourly earnings in the industries employing the largest numbers of heating, air-conditioning, and refrigeration mechanics and installers in 1997 were as follows:

Department stores	\$15.00
Local government, except education and hospitals	14.90
Fuel dealers	14.50
Electrical repair shops	13.40
Plumbing, heating, and air conditioning	12.90

Apprentices usually begin at about 50 percent of the wage rate paid to experienced workers. As they gain experience and improve their skills, they receive periodic increases until they reach the wage rate of experienced workers.

Heating, air-conditioning, and refrigeration mechanics and installers enjoy a variety of employer-sponsored benefits. In addition to typical benefits like health insurance and pension plans, some employers pay for work-related training and provide uniforms, company vans, and tools.

Nearly 1 out of every 5 heating, air-conditioning, and refrigeration mechanics and installers is a member of a union. The unions to which the greatest numbers of mechanics and installers belong are the Sheet Metal Workers' International Association and the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada.

Related Occupations

Heating, air-conditioning, and refrigeration mechanics and installers work with sheet metal and piping, and repair machinery, such as electrical motors, compressors, and burners. Other workers who have similar skills are boilermakers, electrical appliance servicers, electricians, sheet-metal workers and duct installers, and plumbers, pipefitters, and steamfitters.

Sources of Additional Information

For more information about employment and training opportunities in this trade, contact local vocational and technical schools; local heating, air-conditioning, and refrigeration contractors; a local of the unions previously mentioned; a local joint union-management apprenticeship committee; a local chapter of the Associated Builders and Contractors; or the nearest office of the State employment service or State apprenticeship agency.

For information on career opportunities, training, and technician certification, contact:

✦ Air Conditioning Contractors of America, 1712 New Hampshire Ave., NW., Washington, DC 20009.

For information on technician certification, contact:

✦ North American Technician Excellence (NATE), Suite 300, 8201 Greensboro Drive, McLean, VA 22102.

✦ Air Conditioning Contractors of America, 1712 New Hampshire Ave., NW., Washington, DC 20009.

For information on career opportunities and training, write to:

✦ Associated Builders and Contractors, 1300 North 17th St., Rosslyn, VA 22209.

✦ Refrigeration Service Engineers Society, 1666 Rand Rd., Des Plaines, IL 60016-3552.

✦ Home Builders Institute, National Association of Home Builders, 1090 Vermont Ave. NW., Suite 600, Washington, DC 20005.

✦ National Association of Plumbing-Heating-Cooling Contractors, 180 S. Washington St., P.O. Box 6808, Falls Church, VA 22046.

✦ Mechanical Contractors Association of America, 1385 Piccard Dr., Rockville, MD 20850-4329.

✦ Air Conditioning and Refrigeration Institute, 4301 North Fairfax Dr., Suite 425, Arlington, VA 22203.

Home Appliance and Power Tool Repairers

(O*NET 85711A, 85711B, 85944, and 85999A)

Significant Points

- Although employment of home appliance and power tool repairers is expected to grow slowly, opportunities should be good for skilled repairers.
- Many repairers are high school graduates who are trained on the job.
- Knowledge of basic electronics is becoming increasingly important.

Nature of the Work

If your washer, dryer, or refrigerator has ever broken, you know the importance of a dependable repair person. Home appliance and power tool repairers, often called service technicians, keep your home appliances working and help prevent unwanted breakdowns. Some repairers work specifically on small appliances such as microwaves and vacuum cleaners;

others specialize in major appliances such as refrigerators, dishwashers, washers, and dryers. Still others handle power tools or gas appliances.

Repairers visually inspect appliances or power tools and check for unusual noises, excessive vibration, fluid leaks, or loose parts to determine why they fail to operate properly. They use service manuals, troubleshooting guides, and experience to diagnose particularly difficult problems. They disassemble the appliance or tool to examine its internal parts for signs of wear or corrosion. Repairers follow wiring diagrams and use testing devices, such as ammeters, voltmeters, and wattmeters to check electrical systems for shorts and faulty connections.

After identifying problems, they replace or repair defective belts, motors, heating elements, switches, gears, or other items. They tighten, align, clean, and lubricate parts as necessary. Repairers use common hand tools, including screwdrivers, wrenches, files, and pliers, as well as soldering guns and special tools designed for particular appliances. When repairing appliances with electronic parts, they may replace circuit boards or other electronic components.

Many manufacturers incorporate "fuzzy logic" technology into their newer and more expensive appliances. Fuzzy logic technology involves sensors, or inputs, strategically placed inside an appliance to transmit information to an on-board computer. The computer processes this information and adjusts variables such as water and electricity, to optimize appliance performance and reduce wasted resources. Fuzzy logic uses 1 input; "neurofuzzy logic" uses up to 5 inputs; and "chaos logic" uses up to 10 inputs. Dishwashers, washers, and dryers commonly use neurofuzzy logic in their components.

When repairing refrigerators and window air-conditioners, repairers must use care to conserve, recover, and recycle chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants used in their cooling systems as required by law. Repairers conserve the refrigerant by making sure there are no leaks in the system; they recover the refrigerant by venting it into proper cylinders; and they recycle the refrigerant for reuse with special filter-dryers.

Repairers who service gas appliances may check the heating unit and replace tubing, thermocouples, thermostats, valves, and indicator spindles. They also answer emergency calls for gas leaks. To install gas appliances, repairers may have to install pipes in a customer's home to connect the appliances to the gas line. They measure, lay out, cut, and thread pipe and connect it to a feeder line and to the appliance. They may have to saw holes in walls or floors and hang steel supports from beams or joists to hold gas pipes in place. Once the gas line is in place, they turn on the gas and check for leaks.

Repairers also answer customers' questions about the care and use of appliances. For example, they demonstrate how to load automatic



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